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The Effects of Integrating LEGO Robotics into a Mathematics Curriculum to Promote the Development of Proportional Reasoning

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The Effects of Integrating LEGO Robotics Into a Mathematics Curriculum to Promote the Development of Proportional Reasoning



Dr. Shelli Casler-Failing

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Department of Middle Grades and Secondary Education

Existing Research

- Development of proportional reasoning is necessary for students to progress through higher-levels of mathematics (Langrall and Swafford, 2000; Jitendra, Star, Dupuis, & Rodriguez, 2013; Larson, 2013)
- Use of robotics in mathematics has shown positive effects with problem-solving and critical thinking skills (Ardito, Mosley, & Scollins, 2014)
- An extra-curricular one-week intervention provided evidence of improved proportional reasoning skills among 5th grade students (Martinez Ortiz, 2015)

Purpose of the Study

To investigate how the carefully designed incorporation of LEGO Robotics can influence the development of proportional reasoning among seventh grade students.



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Research Questions

1. How does the incorporation of LEGO robotics into a unit on ratios and proportions influence proportional reasoning?
2. In what ways do students reason about distance, rate, and time?

Theoretical Framework

- Vygotsky's Social Constructivist Theory
 - ~learning through social interactions
- Carbonaro, Rex, and Chambers Five Stages of Technology Integration
 - ~engagement, exploration, investigation, creation, and evaluation



(Vygotsky, 1978; Carbonaro, Rex, and Chambers, 2004)

Methodology

- Action research
- Mixed Methods
- Case Study with Embedded Cases



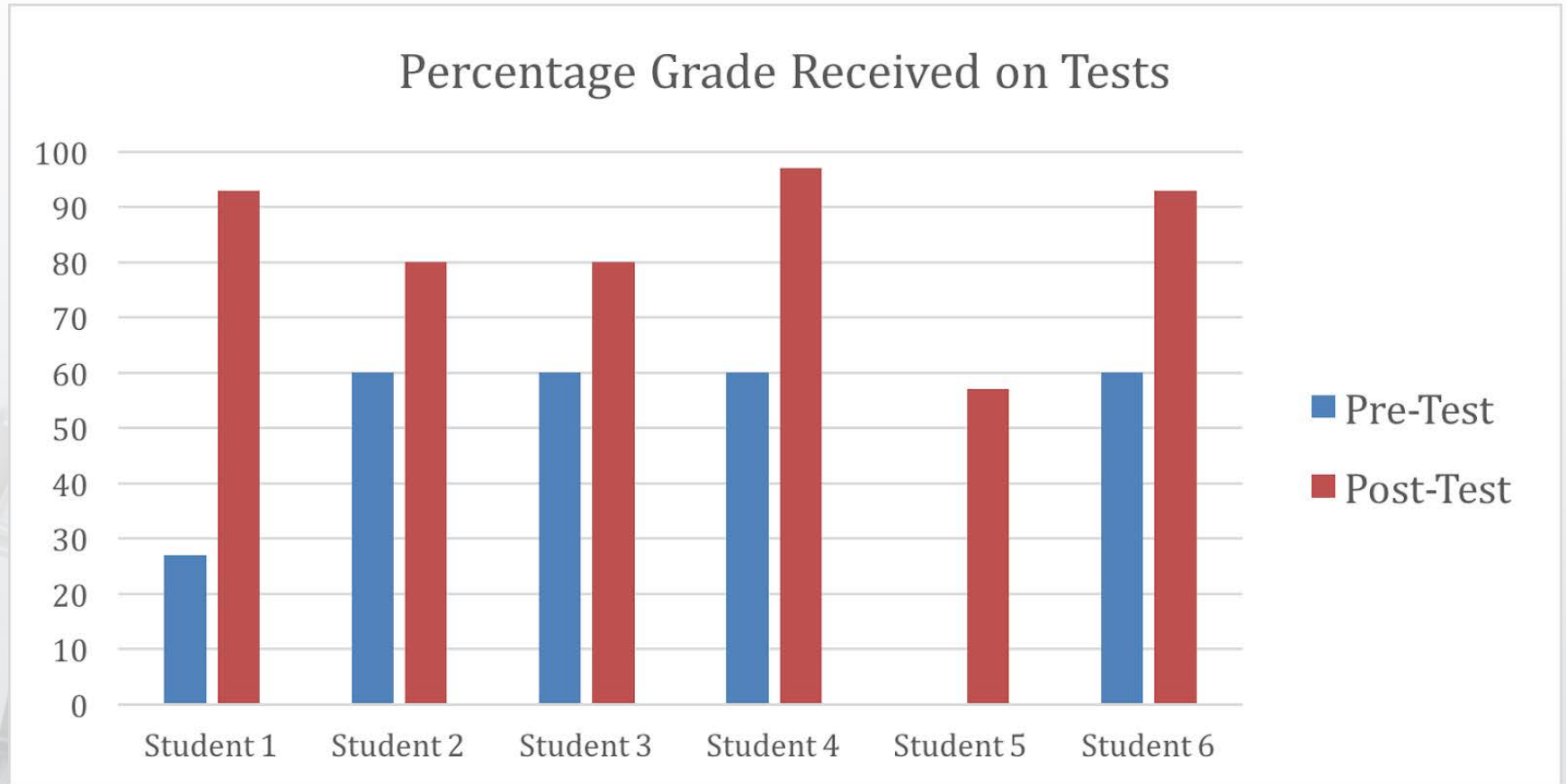
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Data Collection

- regular unit of study
- purposely designed students pairs
- robots required to complete investigations
- discussion before and after each investigation
- activity at end of Investigation 4
- Pre- and post-tests
- Classroom video recordings
- Student interviews
- Field notes
- Student journals and artifacts



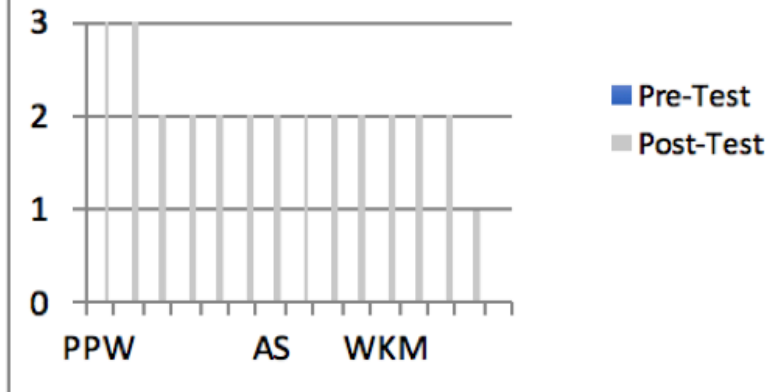
Research Findings



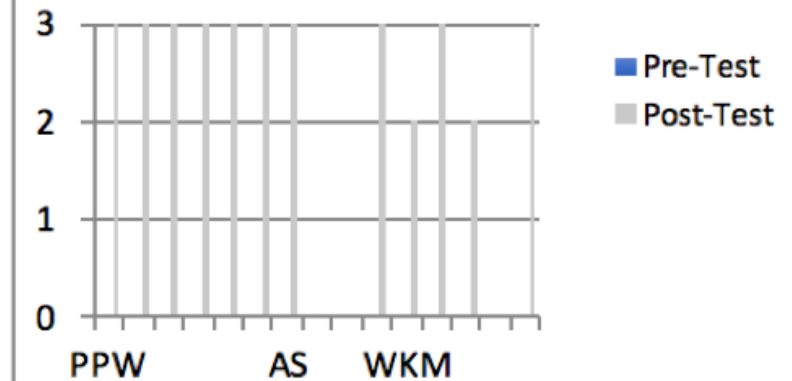
Research Findings

Low-Performing Students

Test Results for Student 1

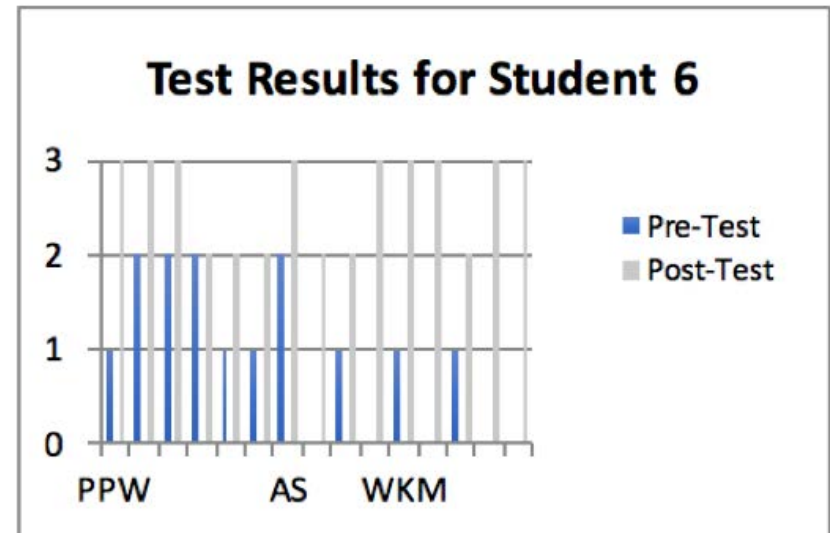
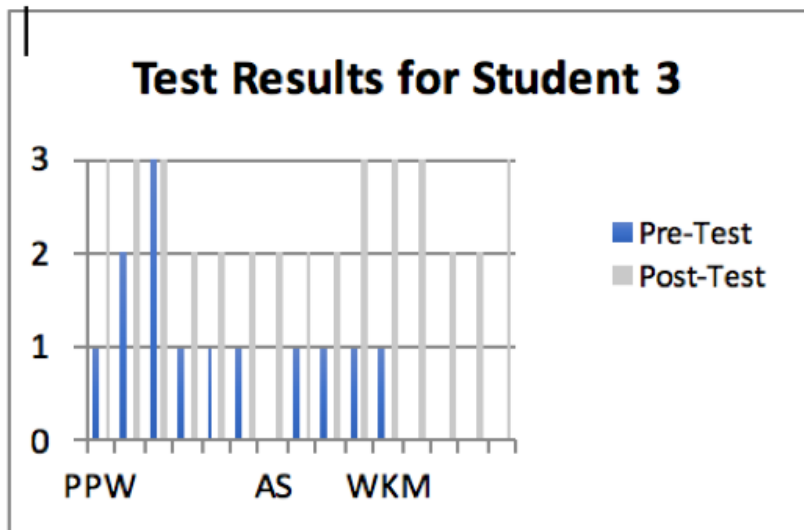


Test Results for Student 5



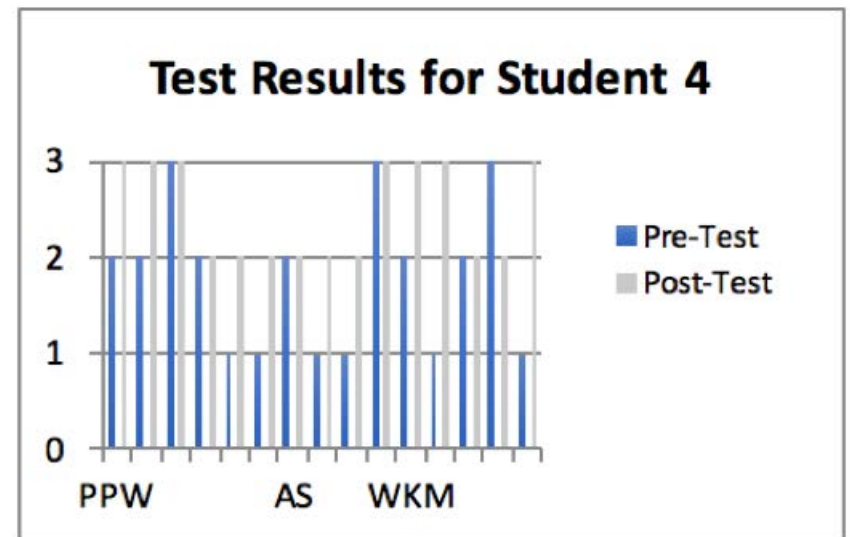
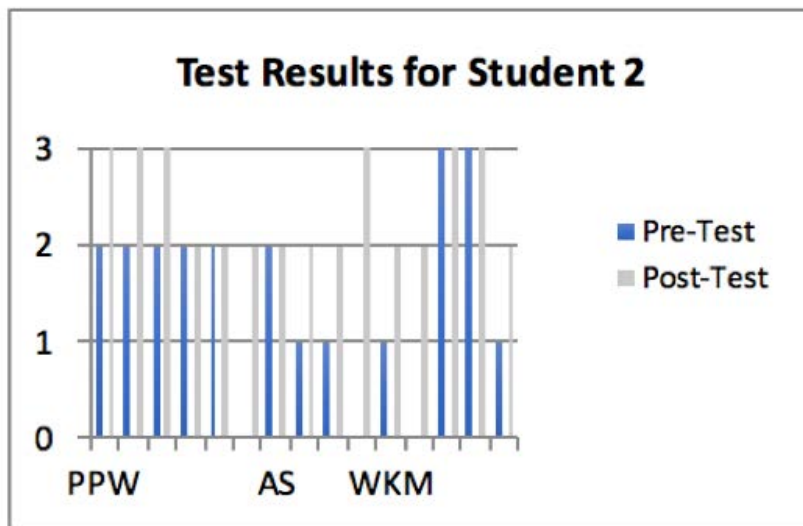
Research Findings

Average-Performing Students



Research Findings

High-Performing Students



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RQ#1 - How does the incorporation of LEGO Robotics into a unit on ratios and proportions influence proportional reasoning?

- Robots create opportunities for discussion via problem-solving
- Discussions (small group and whole class) were analyzed using the four levels of Langrall and Swafford's Proportional Reasoning Rubric (2000)
 - Non-proportional reasoning, Informal reasoning about proportional situations, quantitative reasoning, formal proportional reasoning
- The inclusion of the robots allowed students to see and experience proportionality

RQ#2 - In what ways do students reason about distance, rate, and time?

- Application of Carbonaro, Rex, and Chambers (2004) Five Stages of Technology Integration (engagement, investigation, exploration, creation, and evaluation)
- Verbal communication - both in, and among, groups - as they progress among the stages

Embedded Cases

- Two high-performers and two low-performers
- Importance of mathematics
- Enjoyed learning with LEGO robots
- Developed improved proportional reasoning skills
 - High performers - able to verbalize their understanding
 - Low-performers - had difficulty verbalizing their understanding

Implications

- Provides example of how technology integration can support learning of mathematics
- Learning with robotics allows students to **see** what they learning (e.g., seeing proportionality)
- Sense of play when working with robotics improves perseverance – creates a “can-do” attitude

Limitations

- Primarily qualitative, thus not generalizable to all 7th grade classrooms
- Small class size does not allow for the quantitative findings to be reliable
- Small class size limits the breadth, and depth, of the analysis
- Completed in a school environment where hands-on learning is the norm

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Thank you!

Questions?

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